

Approaches for Downgradient Reactive Transport Modeling at Uranium In-Situ Recovery Sites

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At many uranium in-situ recovery (ISR) sites, restoration efforts have not been able to reach pre-mining conditions for groundwater chemistry. For the proposed Dewey Burdock uranium ISR site in southwestern South Dakota, measurements were taken in order to evaluate the potential for downgradient sorption of uranium. These measurements included core testing with analyses for iron content and batch sorption. Geochemical modeling with PHREEQC indicates that the sorption potential from iron hydroxides alone does not account for the full uranium sorption seen in the batch tests. Using PHREEQC, PEST (an automated calibration routine), and the batch sorption tests, a generalized composite surface complexation model is developed. This model does not use specific sorption materials, but provides generic sorption parameters based on calibration with the batch sorption tests. These sorption parameters are used to simulate 1D reactive transport downgradient from the restored uranium ISR zone, again using PHREEQC. Prediction uncertainty is evaluated using realistic variability in the samples, modeling assumptions, and possible analytical error. With the current data, a small amount of uncertainty creates a large difference in the predictions, to the extent that satisfactory predictions are not possible. Suggestions on ways to reduce uncertainty with additional data, including groundwater chemistry, batch testing, and column testing are provided. Finally, an overall “how to” procedure for reactive transport modeling at future sites is given, with the hope that data collection and modeling efforts at other uranium ISR sites can begin to follow a more standardized approach.